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Standard Operating Procedure

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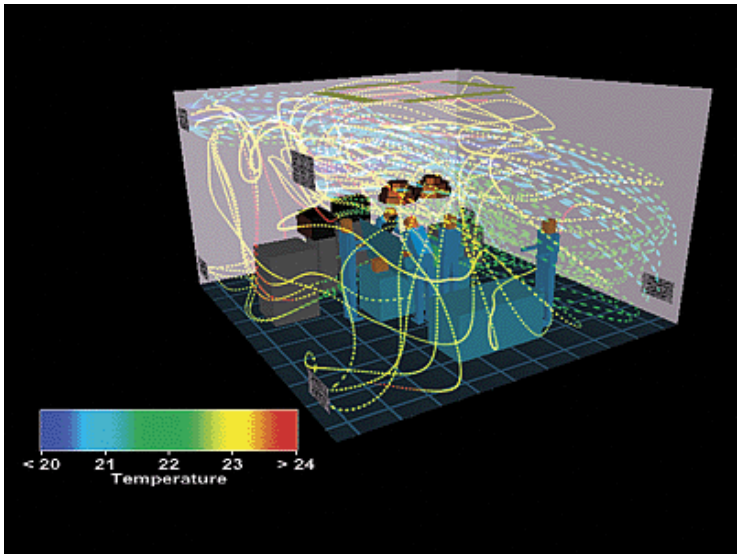


This computer-generated image shows the different airflow patterns in an operating room.

Surgical methods have improved drastically since modern antiseptic surgery began in the 1860s. However, each year, some 700,000 patients in the United States suffer from surgical site infections (SSI). Data show that the direct cost of additional health care of these SSI cases is at least $3.5 billion annually.

Many of these cases are caused by airborne exogenous organisms. Contributions from HVAC engineers have helped impede this pathway of infection, including a significant advance in operating room air distribution design included in ASHRAE's recently published *Design Manual for Hospitals and Clinics*.

ASHRAE is currently taking the information included in this design manual, as well as new research that enhances the modeling of operating room air distribution and infectious particle transport, and incorporating both in its new Standard 170P, Ventilation of Health Care Facilities. ASHRAE is co-sponsoring this standard with the American Society of Healthcare Engineering (ASHE).

The purpose of this standard is to define requirements for ventilation system design, contaminant source management, and air cleaning intended to reduce the transmission of disease in hospital and health care facilities. If all goes according to plan, Standard 170P should be out for its first public review this September.

Hospital Ventilation Different

ASHRAE Standard 170P has been a long time in the making. It started out in January 2000, when ASHRAE formed the Standard Project Committee (SPC) in order to validate and/or modify the ventilation rates for health care spaces that were included in ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality.

Around the same time, ASHRAE was in the process of writing a design manual for health care ventilation (*Design Manual for Hospitals and Clinics*). This manual was not intended to be a standard, so it could not be written in mandatory and enforceable language. However, the committee responsible for writing the design manual, SPC 91, was nervous that its work could be referenced in codes. ASHRAE decided that in order to implement the recommendations in the guideline and incorporate new research results on health care ventilation that had recently been published, a new health care ventilation standard was needed.

Standard 170P is different from Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality, in that it contains much more detailed recommendations for ventilation rates in health care spaces. While Standard 170P addresses many of the spaces in health care facilities, it is not all-inclusive, due to the constantly changing health care delivery system.

According to Richard D. Hermans, P.E., senior project manager for the Center for Energy and Environment (Minneapolis) and chairman of the committee responsible for writing Standard 170P, the scope of the standard is as follows:

- 2.1 The requirements in this standard apply to patient care areas and related support areas within health care facilities including hospitals, nursing facilities, and outpatient facilities.
- 2.2 This standard is intended to apply to new buildings, additions to existing buildings, and those changes to existing buildings that are identified within the standard.
- 2.3 This standard considers chemical, physical, and biological contaminants that can affect the delivery of medical care to patients, the convalescence of patients, and the safety of health care workers and visitors.

“The requirements for health care ventilation in the standard come predominantly from other industry-accepted guidelines such as the Guidelines for Design and Construction of Hospital and Health Care Facilities published by the AIA Press, ASHRAE’s Handbook — HVAC Applications, and the Centers for Disease Control,” noted Hermans. “In addition, we are including some new research findings from the National Institutes of Health.”

It is important to note that this will be a minimum requirement document written in mandatory and enforceable language to reduce

confusion. It is not necessarily a best practice guideline; therefore, the requirements will be concise and without explanation. It's quite possible that many engineers already design health care spaces that are far beyond the recommendations in the standard.

"We are spending a lot of effort towards making the standard as clear as possible, and there should be no surprises," noted Anand K. Seth, P. E., CEM, president, North East Region, Sebesta Blomberg & Associates (Woburn, MA) and a member of the Standard 170P committee. Seth added that a couple of the proposed ventilation rates are different than traditional values, and this will be discussed later.

Exciting New Findings

Hermans is particularly excited about the new research findings from the National Institutes of Health (NIH), which will be included in Standard 170P. Approximately six years ago, Farhad Memarzadeh, Ph. D., P.E., the director of the Division of Policy and Program Assessment at NIH and a member of SPC 91 *Design Manual for Hospitals and Clinics*, agreed to do research that involved computational fluid dynamics (CFD) in operating rooms (ORs).

The NIH conducted the research to address the potential noscomial infections that can occur as a result of the design of the operating room ventilation system. This research was necessary because U.S. standards on the subject are confusing and based on research originally carried out in the 1950s, while international standards vary widely in content and recommendations.

ASHRAE had been trying to do this type of research in operating rooms for decades, but funding was a big issue. Memarzadeh had developed a CFD computer modeling system that he could easily apply to this research. A group of ASHRAE committee members worked with him to develop a computer model of operating rooms, ordinary patient rooms, and isolation rooms. The committee then came up with 12 different ways in which ORs are ventilated.

The standard CFD model for ventilation is able to analyze the specific location of a particle at any point in time under a variety of circumstances. In this OR study, Memarzadeh looked at a certain number of dust particles in a room and determined their location under different ventilation scenarios (to view his complete findings, visit http://orf.od.nih.gov/research.htm). Using the 12 ventilation patterns, Memarzadeh determined through CFD how many particles landed in a patient's open wound, which could have a proportional relationship to increased number of infections.

As Memarzadeh noted, "This research considered the issue of the ventilation system via an examination of squames (skin flakes) in the operating room, and, in particular, their potential contamination of the surgical site."

To address the variance in the different standards, Memarzadeh explained, highly sophisticated airflow modeling and particle-tracking methodologies were used to compare the risk of contaminant deposition on an OR surgical site and back table for different ventilation systems. The airflow methodology was verified by comparison with an extensive set of experimental measurements. A total of 12.9 million experimental (empirical) data values were

collected to confirm the methodologies.

The ventilation system designs considered incorporated commonly used diffuser types, including conventional, laminar, non-aspirating, and displacement diffusers. Further, a range of different air change rates were considered, from 15 to 150 ach, as well as several different operating room layouts and changes in geometry.

“This study is the first of it kind and is the only study that has ever been done that considered the issue of squames in the operating room, and their potential contamination of the surgical site,” noted Memarzadeh.

Through his computer modeling, Memarzadeh came up with suggestions as to how to best ventilate ORs, and this is the information that is being included in Standard 170P. “What’s revolutionary about this research is it answers the question of how fast air moves in the room,” stated Hermans. “Up until this research was done, there were some hints that it might be important how fast the air moves, but nobody could prove it. Everyone just said the only thing that mattered was how fast you turn the air over in the room — the air changes per hour.”

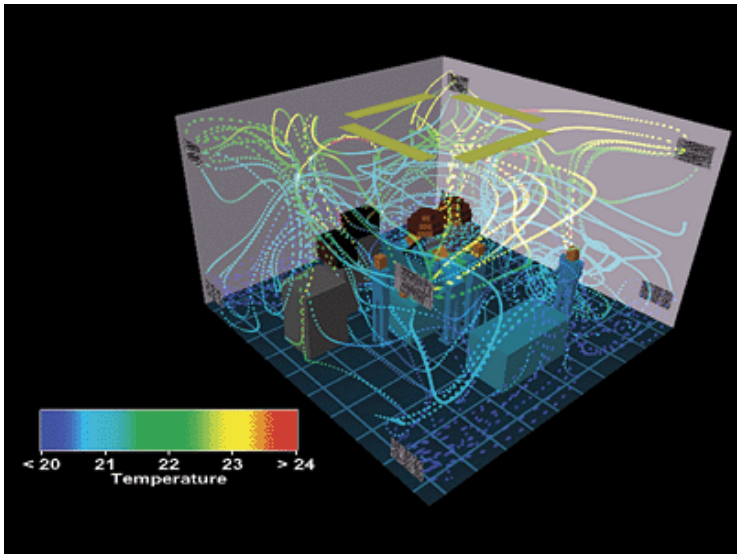
Memarzadeh proved that the air changes per hour were important, but it was just as important to know where the air is directed, how it’s pushed, and how fast it’s going. This all comes back to the face velocity of the diffusers, and Hermans thinks this will make a huge difference in the industry.

“Memarzadeh’s research basically proved the theory that the area around the patient and the back instrument table is what you really care about. If you keep that area clean, you’re in good shape,” stated Hermans. “In order to keep that area clean, the velocity of the air is very important. He showed that if you are careful about the face velocity on your diffusers, the tendency for particles to be pushed into the wound is reduced.”

The reason for this is due to the thermal plume theory, which basically states that the open wound in a patient gives off heat that is usually warmer than the room. In addition, there are operating room lights shining on that same spot, which also heat up the space. Because of the higher temperature, convective air currents flow up out of that space around the wound. Those currents have a tendency to push out airborne particles that would otherwise fall into that space by gravity, and this is called a thermal plume. If operating ventilation systems are designed incorrectly, they counteract that effect, driving organisms down into the wound.

“This is really an exciting new concept,” noted Hermans. “If the air from the ceiling isn’t blowing down harder than the convective air is flowing up from the patient, you’re not driving particles into the wound. It’s encouraging to know that we at least now know a mechanism that helps keep the wound clean.”

Minimum Air Changes



This computer-generated image shows how air moves around a surgical site (wound).

As noted earlier, Standard 170P may include some recommendations that are a bit of a surprise. It has been ASHRAE's recommendation for quite some time to use 25 ach as a minimum in the operating room. Taking Memarzadeh's research into account, SPC 170, the committee writing Standard 170P, has determined that perhaps a minimum of 20 ach may be enough. This is still in the preliminary stages, however, and subject to change.

"It always depends a lot on the heat load in the space, too," said Hermans. "A lot of operating rooms have so much heat-generating equipment in them that you can't possibly cool a space with that little air. And to many designers, this change won't make any difference to them, because they're using higher quantities of air, and they're not going to change. But we looked carefully at the results of this research study, which showed a way where you could use fewer air changes than what ASHRAE had recommended and still maintain aseptic conditions."

We won't know if the new proposed air changes per hour will make it into the final document until after ASHRAE's Summer Meeting in Denver. At the time this article was written, the committee was in the letter ballot process, which meant that committee members were reviewing numerous revisions and recommendations that might alter the standard.

Once committee members vote on those recommendations, the final draft of Standard 170P will be compiled. SPC 170 will then meet in Denver to approve the final draft. SPC 170 will submit the draft document for approval by the ASHRAE Standards Committee and if approved, it will be issued for public review around the third week of September. SPC 170 will then collect the public comments and respond to each of them. If the comments require substantive changes to the text, a second public review will occur. Once the reviews and comment responses are complete the standard will go to the ASHRAE Board of Directors for approval to publish.

Hermans, for one, is looking forward to the standard being published. "Creating a new standard takes a tremendous amount of time, you have to have a thick skin, and it's a nerve-racking process, but it's

definitely exciting." **ES**

ABOUT THE AUTHOR:

Turpin has been with Business News Publishing since 1991, first heading up the company's technical book division before moving over to write for Engineered Systems in 1996. She graduated from the University of Washington and worked on her master's degree in technical communication at Eastern Michigan University. As contributing editor, Turpin writes on a variety of HVACR topics from her sunny location in Phoenix. E-mail her at Joanna Turpin.